RESEARCH IN THE PREDICTION OF SOLAR ACTIVITY

Haimin Wang
Center For Solar Research
New Jersey Institute of Technology
University Heights
Newark, NJ 07102
phone: (973) 596-5781, fax: (973) 596-5794, e-mail: haimin@solar.njit.edu
Hal Zirin
Solar Astronomy
264-33 Caltech
Pasadena, CA 91125
phone:(626) 395-4011, fax: (626) 395-3814, e-mail: hz@caltech.edu
Phil Goode
Big Bear Solar Observatory
40386 North Shore Lane
Big Bear City, CA 92314
phone: (909) 866-5791, fax: (909) 866-4240, e-mail pgoode@tesla.njit.edu
Award #: N00014-9711037

LONG-TERM GOAL

Our long-term goal is to understand the physics of flares and Coronal Mass Ejections and their impact on the earth; and to predict them accurately.

SCIENTIFIC OBJECTIVES

We will predict solar flares by continuation of the BEARALERT program, and intend to issue more alerts with general information on the state of solar activity. Second, we shall investigate the relation between erupting filaments observed at Big Bear and coronal mass ejections (CME) observed from Large Angle Spectroscopic Coronagraph (LASCO). Finally, we shall estimate the ultraviolet solar flux by daily issuance of our K-line index.

APPROACH

We use Big Bear magnetograms and high resolution Halpha movies to evaluate magnetic structures of active regions and issue BearAlerts when we believe that flares will occur soon; We compare Big Bear full disk Halpha movies with SOHO LASCO movies to study the relationship between filament eruptions and Coronal Mass Ejections; We obtain daily full-disk CaK images and compile K-line index to compare with ultraviolet solar flux. People involved in the projects are: Bill Marquette (BearAlerts and Kline index), Hal Zirin (BearAlert), Phil Goode (Comparison of BBSO and LASCO movies), Haimin Wang (Filament Eruption and CME), Ed Komenda (Filament studies), and Anders Johanneson (K-line index).

WORK COMPLETED

K-line indices are on line at BBSO web page; Filament list from 1991 to 1994 has been compiled and studied; Filament eruption in 1996 and 1997 have been compared with LASCO movies; BearAlerts have been improved.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 1997		**00-00-1997 to 00-00-1997**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Research in the Prediction of Solar Activity	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **New Jersey Institute of Technology,Center For Solar Research,Newark,NJ,07102**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**3**	

RESULTS

The following list several results:

1. We have obtained daily CaK images with 1024X1024 Kodak megaplus camera. Each day, the flat field images are obtained, so photometry data can be obtained with high accuracy. Over 95% of correlation between the BBSO Calcium Index and the Lyman-alpha flux has been found. So BBSO K index can be used as good proxy of solar irradiance;
2. Continuous full disk H-alpha images recorded by the Big Bear Solar Observatory from September 1, 1991 to September 12, 1994 (the first three years of Yohkoh mission) were digitized and analyzed. The data set consists of nearly 10,000 H-alpha images, one every half hour for the period when the BBSO was observing. Two statistical studies of the disappearing solar filaments based on this set of data are made: (1) The disk latitude distribution of all larger disappearing filaments with a minimum length of 70 arcsec, including the time of their disappearance. Of the 1095 such filaments, 439 disappeared during our continuous observations, 314 disappeared during the BBSO night gap, 162 disappeared during data gap (more than 24 hours) and 180 rotated beyond the West limb. If we plot latitudes as a function of time for all these disappeared filaments, it showed a uniform distribution in latitude. However, if we plot the distribution of larger disappeared filaments (200 arcsec or above), then the butterfly trend appears-- position of filaments tends to drift to lower latitude as solar activity decreases and (2) The disk distribution of all detectable disappearing filaments, large and small, for the 9-months period, January 1994 to September 1994. We find the size distribution of the 351 collected disappeared filaments follows a power law with a power index of -1.40;
3. The Halpha full-disk images are recorded at Big Bear Solar Observatory using the 2000x2000 Kodak CCD camera from sunrise to sunset on every clear day. These are the best full-disk Halpha images ever made. These images may be seen on the BBSO home page. The data are recorded at a rate of 1 frame per minute. Disk filaments and limb prominences are continuously monitored under the generally excellent observing conditions at BBSO. LASCO, on board SOHO, monitors limb CME directly and detects the halo effect of disk CME. We have studied about 50 events, and 50% of them show correlation between filament disappearances and the onset of CME. We also discovered that Halpha may be brightened a very large areas across the disk, indicating large scale magnetic re-arrangements due to filament eruptions; and
4. The Sun has been quiet, but we still issued about 10 BearAlerts in the past year. For 80% of the case, both the time range and the size of the prediction are accurate.

IMPACT/APPLICATION

Prediction of solar activity is so important in many areas as magnetic eruptions can have deliterious effects on satellites, upper atmosphere communications and even the North American power grid. Thus, it is critical to have the most reliable early warning system possible. For Navy the important factor appears to be their effects on VLF communication and on satellites, such as those involved in communication, surveillance and the global positioning system.

TRANSITIONS

Our data on World Wide Web has been used wide in the world to monitor solar activity. Our BearAlert has helped been highly regarded in the community. The filament list and daily K-index we made have been used by scientists.

RELATED PROJECTS

The PI, Haimin Wang, has been awarded a Space Weather grant by NSF, which established automated early warning system of filament eruption. A computer program is being developed to automatically recognize the structure of filaments. When a filament disappears, this news will be immediately broadcast via E-mail to researchers who are interested in the project and are on our BEARALERT mailing list. The broadcast information will include the time of eruption, and the coordinates and size of the filament. Based on the list of filament eruptions recorded by the automated program, a filament index (as a function of time) will be established.

REFERENCES

Goode, P., and Wang, H., 1997. "Relationship between filament eruptions and CMEs," *Ap. J.*, in preparation.

Johannesson, A., 1997. "Comparison of BBSO CaK index and UARS UV indices," *Ap. J.*, in press.

Wang, H., Komenda, A.E., Tang, F. and Zirin, H., 1997. "Filament Eruptions During the Period of 1991-1994," *Solar Physics*, in press, BBSO #1004.

WEB ADDRESS

http://www.bbso.njit.edu